[Mode for Carrying Out the Invention]

Hereinafter, the present invention is described in detail with reference to the preferred embodiments shown in the accompanying drawings.

[0016]

FIG. 1 is a cross-sectional diagram showing an embodiment of a sliding part for a sewing machine which uses a composition for a sliding member according to the present invention.

[0017]

As shown in FIG. 1, a sliding part 1 for a sewing machine as a sliding member of the present embodiment is formed by a composition for a sliding member in which powder of a porous carbonaceous material is contained in a thermoplastic resin. This sliding part 1 for the sewing machine is formed, for example, in the shape of a pipe having a thickness of from about 1 to about 2 mm and an inner circumferential face thereof is allowed to be a sliding face 1a, which is in sliding contact with another member 2. On this sliding face 1a, a concavoconvex feature having a curvature may be provided. Then, when the concavoconvex feature is provided on the sliding face 1a, not only a contact area of a site which is in sliding contact with the another member 2 can be smaller, but also abrasion powder can be freed to a recessed portion and, accordingly, sliding characteristics can further be enhanced.

[0018]

Examples of such thermoplastic resins each constituting the composition for the sliding member include polyacetal (polyoxymethylene: POM), polyimide (PI), polyamide (nylon: PA), polyamideimide (PAI), polyether ether keton (PEEK), polycarbonate (PC), modified polyphenylene oxide (PPO), polybutylene terephthalate (PBT), polyethylene terephthalate (PET), polysulfone (PSO), polyether sulfone (PES)

polyphenylene sulfide (PPS), polyallylate, polyether imide (PEI), polyethyl ether ketone, thermoplastic fluorine-type resin. Among these thermoplastic resins, polyacetal (POM), polyimide (PI), polyamide (PA, nylon), polyamideimide (PAI) and polyether ether keton (PEEK) are preferred in the sense of being excellent in slidability and, particularly, polyacetal (POM) is most preferred in the sense that, since polyacetal (POM) can consistently be supplied as a low-priced general-purpose engineering plastic which serves as a metal-substituting resin, not only the price is low and the stable supply is facilitated, but also an efficient production can be performed by injection molding. In the present embodiment, polyacetal is used.

[0019]

The porous carbonaceous material constituting the composition for the sliding member is a so-called RB (Rice Bran) Ceramics and an article which is formed by firing a raw material composition in which rice bran is blended with a phenol resin at a high temperature of 500°C or more is ordinarily used. Then, the raw material composition becomes a glassy carbonaceous component (glassy graphite) formed by a carbide of the phenol resin by firing and, at the same time, a porous site in which a void is wrapped by a shell of the glassy carbonaceous component and a fine, dense site of the glassy carbonaceous component having no void are formed. Further, as for the raw material composition of the porous carbonaceous material, in place of the rice bran, various types of bran such as wheat bran, rice husk and bean husk can be used either singly or in combinations thereof. Still further, as for the thermosetting resins, such thermosetting resins as a furan resin and a melamine resin can be used.

[0020]

In the composition for the sliding member of the present embodiment, powder of the above-described porous carbonaceous material can be used. This powder of

the porous carbonaceous material can easily be obtained by firstly crushing the porous carbonaceous material by using a known crusher and, then, classifying the thus-crushed article by using a sieve or the like.

[0021]

As for blending amounts of the thermoplastic resin and the powder of the porous carbonaceous material in the composition for the sliding member, it is preferred that a content of the powder of the porous carbonaceous material is from about 10 to about 50% by weight and, preferably, from about 30 to about 50% by weight and the rest comes to be a content of the thermoplastic resin.

[0022]

In other words, the composition for the sliding member is prepared by allowing the powder of the porous carbonaceous material to be contained in the thermoplastic resin and it is preferred that ratios of the thermoplastic resin and the powder of the porous carbonaceous material are, based on the entire weight, in the range of from 50 to 90% by weight and in the range of from 10 to 50% by weight, respectively.

[0023]

When the content of the powder of the porous carbonaceous material is smaller than the above-described range, a function of the porous carbonaceous material in which the porous carbonaceous material becomes hard and the friction resistance under no lubrication can be suppressed low is unlikely to be performed and, then, when such composition as described above is made to be the sliding part 1 for the sewing machine, reduction of a coefficient of friction of a sliding face 1a or enhancement of abrasion resistance can not be realized. Accordingly, it becomes difficult to surely prevent the abrasion of the sliding site or a damage due to burning

out over a long period of time under no lubrication. Further, when the amount of the powder of the porous carbonaceous material becomes larger than the above-described range, it tends to be difficult not only to blend the powder of the porous carbonaceous material in the thermoplastic resin but also to secure flowability necessary for performing a molding process at the time of subjecting the composition for the sliding member to the molding process.

[0024]

Therefore, by setting the content of the thermoplastic resin to be from 50 to 90% by weight and the content of the powder of the porous carbonaceous material to be from 10 to 50% by weight, respective most favorable contents necessary for surely preventing abrasion of the sliding site or the damage due to burning out over a long period of time under no lubrication without impairing the flowability at the time of subjecting the composition for the sliding member to the molding process can be obtained.

[0025]

A grain size of the powder of the porous carbonaceous material is preferably from 2 to 100 μm. When the grain size of the powder of the porous carbonaceous material is less than 2 μm, the powder tends to be agglomerated. Further, when the grain size thereof is more than 100 μm, not only the powder of the porous carbonaceous material becomes hard to be mixed in the thermoplastic resin, but also it tends to hardly secure the flowability required to perform a molding process which is subjected when the composition for the sliding member undergoes the molding process.

[0026]

Therefore, by setting the grain size of the porous carbonaceous material to be

from 2 to 100 μm, the most favorable grain size necessary for surely preventing the abrasion of the sliding site or the damage due to burning out over a long period of time under no lubrication without impairing the flowability at the time of subjecting the composition for the sliding member to the molding process can be obtained.

[0027]

Further, the powder of the porous carbonaceous material may be impregnated with a solution of a fluorine-type resin. Then, when such constitution as described above is adopted, since the fluorine-type resin can be carried by the powder of the porous carbonaceous material, realization of a lower friction of the sliding part 1 for the sewing machine which is the sliding member can further be performed. Namely, realization of the lower friction of the sliding face 1a can be maintained over a long period of time. Further, when the solution of the fluorine-type resin is impregnated in the powder of the porous carbonaceous material, it is favorable to perform such impregnation in vacuum because, in vacuum, the fluorine-type resin can efficiently be impregnated in the powder of the porous carbonaceous material in a short period of time. Further, in place of the fluorine-type resin, a lubricating member having thermal resistance such as a fluorocarbon oil may be used. Such thermal resistance of the lubricating member is permissible so long as the lubricating member can be prevented from being sublimated as a gas by heat in a production process. Namely, when the composition for the sliding member is changed into pellets as described below and, also, when the pellets are formed into the sliding part 1 for the sewing machine by being subjected to the molding process, the composition for the sliding member is fluidized by being heated at, for example, about 190°C and, therefore, it is vital that the composition can withstand the temperature at the time of such fluidization.

[0028]

Further, various types of blending materials such as a black pigment may be added to the composition for the sliding member of the present embodiment so long as they do not give any detrimental effect to the composition.

[0029]

Now, a method for producing the sliding part 1 for the sewing machine of the present embodiment is described.

[0030]

The sliding part 1 for the sewing machine of the present embodiment is produced by firstly setting pellets of a composition for a sliding member in which polyacetal as a thermoplastic resin is allowed to contain the powder of the porous carbonaceous material as being a material and, then, subjecting the thus-set material to the molding process.

[0031]

As for the pellets, for example, polyacetal as the thermoplastic resin and the powder of the porous carbonaceous material are mixed with each other by fluidizing polyacetal at a temperature of about 180°C by using a twin screw extruder and, then, cooled, to thereby prepare a formed product in a rod shape having a diameter of, for example, about 2 mm. Next, a tip end of the formed product in the rod shape is continuously cut by a length of, for example, about 2 mm, to thereby easily obtain the pellets.

[0032]

The sliding part 1 for the sewing machine can easily efficiently be obtained such that the pellets are fluidized at a temperature of about 190°C by using an injection molding machine and the thus-fluidized material is injected in a cavity of a molding

die and, then, the material fluidized in the cavity is subjected to a solidify-molding process and, thereafter, the thus-solidified material is removed from the molding die. Further, a shape and a size of the sliding part 1 for the sewing machine are determined in accordance with a shape and a size of the molding die.

[0033]

Therefore, the sliding part 1 for the sewing machine as a sliding member can easily, efficiently be obtained in an arbitrary shape by a simple step of allowing the composition for the sliding member to be fluidized and subjected to the molding process.

[0034]

Further, the solution of the fluorine-type resin may be impregnated in a finished sliding part 1 for the sewing machine. Then, by adopting such constitution as described above, since the fluorine-type resin can be carried in a porous site 4 which is exposed on a sliding face 1a, realization of a lower friction of the sliding face 1a of the sliding part 1 for the sewing machine which is a sliding member can further be performed. Namely, the lower friction of the sliding face 1a can be maintained for a long period of time. Further, when the solution of the fluorine-type resin is impregnated in the sliding part 1 for the sewing machine, it is preferable to perform such impregnation in vacuum, since, in vacuum, the fluorine-type resin can efficiently be impregnated in the porous site 4 of the powder of the porous carbonaceous material which is exposed on the sliding face 1a in a short period of time.

[0035]

Further, in place of the fluorine-type resin, any one of various types of lubricants such as fluorocarbon oil, and a lubricating member such as grease can be used.

[0036]

Next, an operation of the present embodiment having the above-described constitution is described.

[0037]

FIG 2 is a schematic diagram showing a structure of a vicinity of a sliding face in the embodiment of a sliding part for a sewing machine, which uses a composition for a sliding member according to the present invention.

[0038]

As shown in FIG. 2, the sliding part 1 for the sewing machine of the present embodiment has a structure such that the relatively large porous site 4 of the glassy graphite formed in a size of 100 μm at the maximum and the fine, dense site 5 of the glassy graphite formed in a size of 2 μm at the minimum are scattered in the polyacetal resin 3 and is constituted such that some portions of the site 4 and the site 5 are exposed on the sliding face 1a. Namely, the sliding face 1a is constituted by the polyacetal resin 1, the porous site 4 of glassy graphite and the fine, dense site 5 formed by the glassy graphite dispersed in this polyacetal.

[0039]

Therefore, at least the sliding face 1a of the sliding part 1 for the sewing machine of the present embodiment is constituted by simultaneously having excellent mechanical strengths such as a tensile strength and a bending strength which are obtained by polyacetal, an excellent sliding abrasion resistance which is obtained by polyacetal, an excellent abrasion resistance due to hardness and a low friction coefficient due to a self lubricating property both of which are obtained by the porous carbonaceous material.

[0040]

As described above, since the composition for the sliding member of the present embodiment is allowed to simultaneously have a low coefficient of friction necessary as a sliding member and a function which can make a fluctuation of the coefficient of the friction against a fluctuation of a load small and an excellent mechanical strength as a metal-substituting resin, the abrasion of the sliding site and the damage due to burning out can surely be prevented over a long period of time under no lubrication.

[0041]

Further, according to the composition for the sliding member of the present embodiment, the composition for the sliding member in which the powder of the porous carbonaceous material is allowed to be contained in polyacetal is changed into pellets and, then, since the sliding part 1 for the sewing machine as a sliding member can be formed by subjecting the pellets to injection molding, a size change after forming is not generated. Since a post-machining treatment is not necessary, labor and time to be consumed for such machining can be curtailed and, accordingly, productivity is enhanced and a reduction in cost can easily be realized.

[0042]

Still further, since the composition for the sliding member of the present embodiment in which the powder of the porous carbonaceous material is formed so as to contain polyacetal therein, fluidization is performed at the time of forming and, accordingly, an arbitrary shape can easily be obtained. Furthermore, since a repeated fluidization can be performed by heating the formed product again, the formed product can be used again as a material for the sliding part 1 for the sewing machine. Namely, recycling can easily be performed.

[0043]

Still furthermore, according to the composition for the sliding member of the present embodiment, since the powder of the porous carbonaceous material constituting a portion of the composition for the sliding member is formed with the glassy carbon (graphite), an entire coefficient of thermal conductivity of the sliding part 1 for the sewing machine as the sliding member formed by the composition for the sliding member can be enhanced. Then, by enhancing the coefficient of thermal conductivity of the sliding part 1 for the sewing machine, heat generation and heat storage of the sliding part 1 for the sewing machine at the time of sliding can be reduced. Namely, a poor coefficient of the thermal conductivity which is a weak point of resins can easily be improved.

[0045]

Further, a relation between a bending strength of the sliding member which uses the composition for the sliding member of the present embodiment and a content (blending amount) of the powder of the porous carbonaceous material was examined and the results are shown in FIG. 3.

[0046]

As is apparent from these test results, in the sliding member which uses the composition for the sliding member of the present embodiment, it was confirmed that, as the amount of the powder of the porous carbonaceous material becomes larger, the bending strength tends to be reduced and, also, when the content of the powder of the porous carbonaceous material is in the range of from 30 to 50% by weight, the bending strength comes to be in a nearly same level. This bending strength is in a level which has no practical problem.

[0047]

Further, a relation between a coefficient of friction of the sliding member

which uses the composition for the sliding member of the present embodiment, a load and a content (blending amount) of the powder of the porous carbonaceous material was examined and the results are shown in FIG. 4. Still further, in FIG. 4, an article in which a solution of a fluorine-type resin was impregnated in the sliding member after it was formed is also shown. Even still further, as for a testing apparatus, a journal bearing-type abrasion testing machine was used.

[0048]

As is apparent from the results of this test, in the sliding member which uses the composition for the sliding member of the present embodiment, it was confirmed that, as the content of the powder of the porous carbonaceous material is increased, the coefficient of friction is reduced and, also, a fluctuation of the coefficient of friction against the load becomes smaller. Then, by setting the content of the powder of the porous carbonaceous material to be from 30 to 50% by weight, not only the fluctuation of the coefficient of friction against the load can be put in a narrowest range, but also the coefficient of friction can be made to be 0.2 or less. Namely, the coefficient of friction can easily be reduced. Further, it was confirmed that, when the solution of the fluorine-type resin was impregnated, the fluctuation of the coefficient of friction against the load in a low load region was able to be smaller.

[0049]

Still further, a relation between a heat generation temperature of the sliding member which uses the composition for the sliding member of the present embodiment and a content of the powder of the porous carbonaceous material was examined while applying 39 N as the load and the results are shown in FIG. 5. Even still further, the heat generation temperature shown in the axis of ordinate denotes a changed temperature which was obtained by subtracting a room temperature from a measured

temperature.

[0050]

As is apparent from these test results, it was confirmed that, in the sliding member which used the composition for the sliding member of the present embodiment, as the content of the powder of the porous carbonaceous material was increased, the heat generation temperature was reduced.

[Brief Description of the Drawings]

[FIG. 1] It is a cross-sectional diagram showing an embodiment of a sliding part for a sewing machine which uses a composition for a sliding member according to the present invention.

[FIG. 2] It is a schematic diagram showing a structure of a vicinity of a sliding face in an embodiment of a sliding part for a sewing machine which uses a composition for a sliding member according to the present invention.

[FIG. 3] It is a diagram showing a relation between a bending strength of a sliding member which uses a composition for a sliding member according to the present invention and a content of powder of a porous carbonaceous material.

[FIG. 4] It is a diagram showing a relation between a coefficient of friction of a sliding member which uses a composition for a sliding member according to the present invention, a load and a content of powder of a porous carbonaceous material.

[FIG. 5] It is a diagram showing a relation between a heat generation temperature of a sliding member which uses a composition for a sliding member according to the present invention and a content of powder of a porous carbonaceous material.

[Description of Reference Numerals and Signs]

1. sliding part for sewing machine
1a. sliding face
2. another part
3. polyacetal resin
4. (porous) site (in powder of porous carbonaceous material)
5. (fine, dense) site (in powder of porous carbonaceous material)

FIG. 3

ORDINAL AXIS: BENDING STRENGTH

ABSCISSA AXIS: CONTENT OF POWDER OF POROUS CARBONACEOUS MATERIAL (% BY WEIGHT)

FIG. 4

CONTENT OF POWDER OF POROUS CARBONACEOUS MATERIAL: 10% BY WEIGHT

CONTENT OF POWDER OF POROUS CARBONACEOUS MATERIAL: 30% BY WEIGHT

CONTENT OF POWDER OF POROUS CARBONACEOUS MATERIAL: 50% BY WEIGHT

CONTENT OF POWDER OF POROUS CARBONACEOUS MATERIAL: 30% BY WEIGHT PLUS POST-IMPREGNATION OF SOLUTION OF FLUORINE-TYPE RESIN

ORDINAL AXIS: COEFFICIENT OF FRICTION

ABSCISSA AXIS: LOAD (N)

FIG. 5

ORDINAL AXIS: HEAT GENERATION TEMPERATURE (°C)

ABSCISSA AXIS: CONTENT OF POWDER OF POROUS CARBONACEOUS MATERIAL (% BY WEIGHT)

(LOAD: 39 N)

JP-A-2002-30222

① "...content of powder of porous carbide material" is 10%
② " " is 30 wt%
③ " " is 50 wt%
④ " " is 30 wt%, and dip in fluorine-based resin solution.

Fig. 1 【図１】

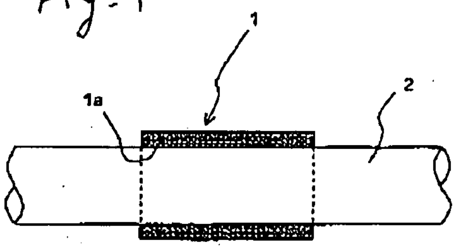
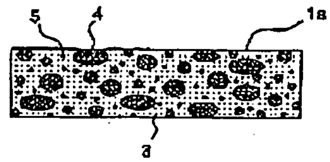
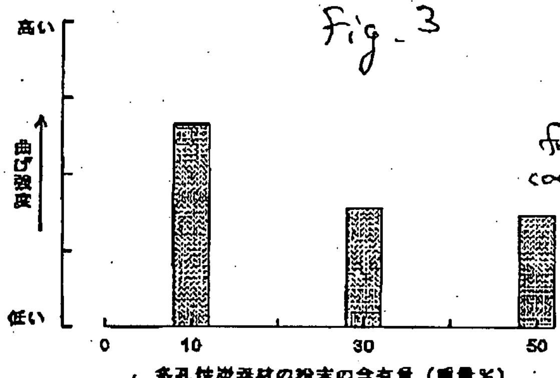


Fig. 2 【図２】

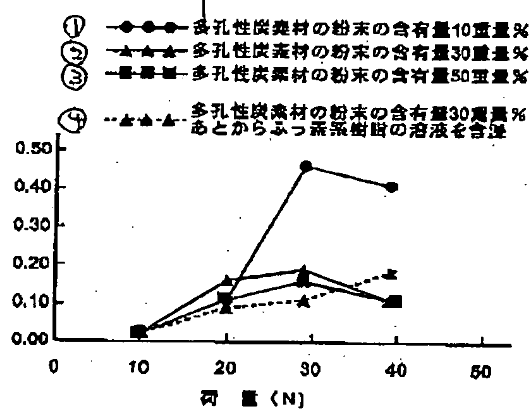


【図３】 Fig. 3



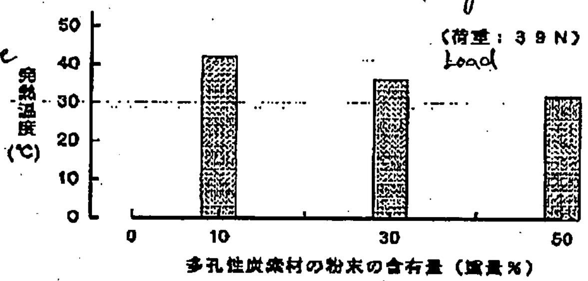
content of powder of porous carbide material (wt %)

【図４】 Fig. 4



load

【図５】 Fig. 5



content of powder of porous carbide material (wt %)

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